(54) **CDMA communication with multiplex transmission of data over a long distance with a low to a high rate**

CDMA Kommunikation mit Multiplexübertragung von Daten über eine grosse Entfernung mit niedriger bis hoher Rate

Communication CDMA avec transmission multiple de données sur une grande distance d'un débit faible à un débit élevé

(72) Inventors:
• Adachi, Fumiyuki
Yokohama-shi, Kanagawa 236 (JP)
• Sawahashi, Mamoru
Yokosuka-shi, Kanagawa 239 (JP)
• Dohi, Tomohiro,
NTT Tomioka Daiichi Dokushin-ryo
Yokohama-shi, Kanagawa 235 (JP)
• Uebayashi, Shinji
Yokohama-shi, Kanagawa 236 (JP)

EP 0 652 650 B1

Description

[0001] The present invention relates to a CDMA (Code Division Multiple Access) communications method and system preferably applied to mobile communications.

[0002] Closest prior art is document WO-A-9 315 502 which discloses a method and a system for the arrangement of vocoder data for the masking of transmission channel induced errors.

[0003] CDMA communication systems carry out a primary modulation of original data to be transmitted by QPSK or the like, and a secondary modulation of the primary modulation signal to enlarge the bandwidth by a spreading code such as a PN code (Pseudo-Noise code). The bit rate of the spreading code is called a chip rate, which is several tens to several hundreds times higher than the bit rate of the original data. Each user performs communications using the same frequency band, and is identified by a spreading code.

[0004] Conventional CDMA systems arrange the original data into frames, perform the primary and secondary modulations of the frames, and transmit them. During communications, there are silent intervals, in which the modulations are stopped, and the transmission is interrupted. This prevents useless radio waves from being emitted, thereby suppressing interference power to other mobile stations. On the other hand, data whose transmission bit rate is less than that of voice coded data is transmitted by making vacant positions in a bit series in a frame, and stopping modulation of the vacant positions. The modulation is interrupted in either case. However, since the interruption is carried out in a random manner, the receiving side cannot utilize this vacant time for other purposes such as receiving broadcasting information transmitted from base stations.

[0005] Data rates of voice codecs for cellular systems are ranging from 8-16 kbps. Low rate data (e.g., 1.2-4.8 kbps) as well as facsimile data are also handled as important cellular services. Furthermore, it will become necessary in the near future to transmit signals of the ISDN (Integrated Service Digital Network) in addition to the low bit rate data transmission. Image codecs currently available generally employ transmission rates of 64 kbps or 384 kbps. To achieve flexible transmissions of low rate data to high rate image data, the multimedia transmission including images requires code division multiplexing in the CDMA systems.

[0006] Figs. 1A - 1C illustrate a code division multiplexing method when a high rate transmission is carried out in a conventional CDMA system. Fig. 1A shows a fundamental channel whose fundamental transmission rate is f_b bps. A frame includes a synchronizing word SW, and a traffic channel TCH. Figs. 1B and 1C illustrate the frame arrangements when the transmission rate is twice and four times as that of the fundamental transmission rate, respectively. When the transmission rate is twice, that is, $2f_b$ bps, two traffic channels are transmitted in parallel by using two different spreading codes (which is referred to as a two-channel parallel transmission) as shown in Fig. 1B, and when the transmission rate is four times, $4f_b$ bps, the data is transmitted by the four-channel parallel transmission as shown in Fig. 1C.

[0007] When the transmission rate of a coded voice signal is 8 kbps, for example, and this transmission rate is adopted as the fundamental transmission rate of a fundamental channel, an 8-channel code division multiplexing is required to transmit data at a transmission rate of 64 kbps. Moreover, a 256-channel code division multiplexing is required to transmit data at a transmission rate of 2 Mbps.

[0008] The conventional CDMA systems determine the transmission rate of the coded voice signal, which is most frequently used, as the fundamental transmission rate of the channel, and makes a frame corresponding to the fundamental transmission rate as the fundamental frame. A high-speed transmission such as multimedia transmission is performed by parallel transmission of a plurality of fundamental channels at the transmitting side, and by discriminating the individual channels by correlators at the receiving side. This presents a problem in that the circuit scale of a transmitter and a receiver increases with the degree of multiplexing.

[0009] Furthermore, in the CDMA mobile communications, communication quality will be degraded as a mobile station moves apart from a base station during communications. Accordingly, to maintain a high quality communication state, it becomes necessary to search for a new base station close to the mobile station during the communication and connect the mobile station to the new base station.

[0010] However, since a user occupies the entire frame for the communication, and there is no vacant time in the frame time for searching for a new base station to be connected, it is impossible to detect the new base station, to which the mobile station switches the communication. Therefore, the detection must be performed at the base station side rather than the mobile station side. More specifically, both the base station which is communicating with the mobile station, and neighboring base stations receive the signal from the mobile station, measure the power of the received signal, and selects the base station whose received signal has the maximum power as the new base station. This, however, presents a problem in that an amount of processing at the base station side increases with the increase in the number of the mobile stations. On the other hand, to perform this detection at the mobile station side, the mobile station must be provided with another secondary demodulation system (or decorrelator) for measuring the power of the control channels transmitted from neighboring base stations.

[0011] Each base station continuously or periodically transmits, through a common control channel, position information of the base station, and spreading codes used by the neighboring base stations, as well as com-

munication data to mobile stations. In addition, broadcasting data such as weather forecast and stock prices, and paging data can also be transmitted. To receive these data (broadcasting data or paging data) during the communication, a conventional mobile station requires another demodulation system in addition to the demodulation system for the original communications.

[0012] Providing two demodulation systems in the mobile station presents a problem in that it will increase size, weight, and consuming power of the mobile station.

[0013] An embodiment of the present invention providesa CDMA communications method and system which can implement variable rate data transmission from a high-rate to low-rate with a small amount of an increase in circuitry of transceivers.

[0014] An embodiment of the present invention provides a CDMA communications method and system which can detect a base station, to which a mobile station is to be newly connected, at the mobile station side during the communication.

[0015] In another embodiment the present invention provides a CDMA communications method and system, wherein a mobile station can receive various channel data transmitted from base stations while the mobile station is communicating.

[0016] In a first aspect of the present invention, there is provided a CDMA (Code Division Multiple Access) communications method for transmitting transmission data through one or more channels between base stations and a mobile station, said method comprising the steps of:

> generating a frame including at least a part of said transmission data;
> performing a primary modulation of said frame to produce a primary modulation signal;
> performing a secondary modulation of said primary modulation signal using a spreading code, to produce a secondary modulated wideband signal, said spreading code being different for each of said channels; and
> transmitting said wideband signal using a carrier;

> characterised in that said step of generating a frame comprises the step of time compressing said transmission data by a factor of N at every time period T when the transmission rate of said transmission data is 1/N of a predetermined transmission rate, where N is an integer greater than one, and T is the length of a frame at said predetermined transmission rate, thereby providing said frame with a vacant portion when a transmission rate of said transmission data is lower than said predetermined transmission rate, said vacant portion having no data to be transmitted.

[0017] Here, the step of generating a frame may comprise the step of determining a frame length such that the frame includes no vacant portion when data is transmitted at the predetermined transmission rate.

[0018] The minimum transmission rate may be a rate of transmitting a voice signal.

[0019] The CDMA communications method may further comprise the step of generating a plurality of frames to be assigned to a plurality of the channels when data is transmitted at a rate higher than the fundamental transmission rate.

[0020] The CDMA communications method may further comprise the steps of:

> obtaining the primary modulation signal by receiving a wideband signal associated with one of the channels, and by despreading the wideband signal using a spreading code; and
> restoring the transmission data by primarily demodulating the primary modulation signal obtained at the step of obtaining, and by time expanding the demodulation output by a factor of N.

[0021] The CDMA communications method may further comprise the steps of:

> measuring received power of a common control channel signal transmitted from a base station other than a base station with which the mobile station is communicating, by switching the spreading code during a time period corresponding to the vacant portion in the frame; and
> deciding during communications a base station to which the communication is to be switched in accordance with the received power.

[0022] The CDMA communications method may further comprise the steps of:

> receiving common control channel data transmitted from at least one of the base stations during a time period corresponding to the vacant portion of the frame by switching the spreading code; and
> demodulating the common control channel data.

[0023] The step of generating a frame may comprise the step of generating a frame from the transmission data by using a plurality of T/N long portions in the frame, the transmission data having a transmission rate equal to or less than (N-1)/N times of the fundamental transmission rate of the channel, where N is an integer equal to or greater than three.

[0024] In a second aspect of the present invention there is provided a CDMA (Code Division Multiple Access) communications apparatus for transmitting transmission data through one or more channels between base stations and a mobile station, said apparatus comprising:

> means for generating a frame including at least a part of said transmission data;

means for performing a primary modulation of said frame to produce a primary modulation signal;
means for performing a secondary modulation of said primary modulation signal using a spreading code, to produce a secondary modulated wideband signal, said spreading code being different for each of said channels; and
means for transmitting said wideband signal using a carrier;

characterised in that said means for generating a frame comprises means for time compressing said transmission data by a factor of N at every time period T when the transmission rate of said transmission data is 1/N of a predetermined transmission rate, where N is an integer greater than one, and T is the length of a frame at said predetermined transmission rate, thereby providing said frame with a vacant portion when a transmission rate of said transmission data is lower than said predetermined rate, said vacant portion having no data to be transmitted.

[0025] The means for generating a frame may comprise means for determining a frame length such that the frame includes no vacant portion when data is transmitted at the fundamental transmission rate.

[0026] The minimum transmission rate may be a rate of transmitting a voice signal.

[0027] The CDMA communications apparatus may further comprise means for generating a plurality of frames to be assigned to a plurality of the channels when data is transmitted at a rate higher than the fundamental transmission rate.

[0028] The CDMA communications apparatus may further comprise:

means for obtaining the primary modulation signal by receiving a wideband signal associated with one of the channels, and by despreading the wideband signal using a spreading code; and
means for restoring the transmission data by primarily demodulating the primary modulation signal obtained by the means for obtaining, and by time expanding the demodulation output by a factor of N.

[0029] The CDMA communications apparatus may further comprise:

means for measuring received power of a common control channel signal transmitted from a base station other than a base station with which the mobile station is communicating, by switching the spreading code during a time period corresponding to the vacant portion in the frame; and
means for deciding during communications a base station to which the communication is to be switched in accordance with the received power.

[0030] The CDMA communications apparatus may further comprise:

means for receiving common control channel data transmitted from at least one of the base stations during a time period corresponding to the vacant portion of the frame by switching the spreading code; and
means for demodulating the common control channel data.

[0031] The means for generating a frame may comprise means for generating a frame from the transmission data by using a plurality of T/N long portions in the frame, the transmission data having a transmission rate equal to or less than (N-1)/N times of the fundamental transmission rate of the channel, where N is an integer equal to or greater than three.

[0032] According to an aspect of the present invention, since a transmission rate greater than the widely used voice transmission rate (8 kbps, for example) is selected as the fundamental transmission rate, the number of channels to be multiplexed is reduced as compared with that of the conventional systems when data of a higher transmission rate is transmitted. As a result, the circuit scale of a multiplexing circuit, and that of a division circuit can be reduced. In addition, although a data transmission requires the entire channel even if its transmission rate is less than the fundamental transmission rate, the average transmission power is reduced because only part of the frame is used in this case, and hence, the interference power to other channels are reduced. As a result, capacity in terms of the number of subscribers of the system in accordance with the present invention is the same as that of the conventional CDMA system using a minimum transmission rate as the fundamental rate. In other words, the present invention, which adopts a rate higher than the minimum transmission rate as the fundamental rate, is not inferior to the conventional system in capacity in terms of the number of subscribers.

[0033] In addition, since a vacant portion is provided in each frame when a transmission rate is lower than the fundamental transmission rate, a mobile station can receive, during the communication, the common control data from other base stations by switching spreading codes in the vacant portion. Furthermore, comparing the received powers of common control channels transmitted from neighboring base stations makes it possible to determine the base station, to which the mobile station is to be newly connected. In this case, since the two demodulation systems which are required in the conventional mobile station can be replaced with a single demodulation system, the increase in hardware is small.

[0034] The above and other objects, effects, features and advantages of the present invention will become more apparent from the following description of the embodiments thereof taken in conjunction with the accompanying drawings.

Figs. 1A - 1C are schematic diagrams illustrating channel arrangements of a conventional parallel transmission method at various transmission rates;

Figs. 2A - 2D are schematic diagrams illustrating channel arrangements of a parallel transmission method in accordance with the present invention at various transmission rates;

Fig. 3 is a block diagram showing an embodiment of a transmitter of a base station, to which the parallel transmission method in accordance with the present invention is applied;

Fig. 4 is a block diagram showing an embodiment of a receiver, to which the parallel transmission method in accordance with the present invention is applied;

Fig. 5 is a block diagram showing a base station, to which the CDMA communications method in accordance with the present invention is applied;

Figs. 6A - 6C are schematic diagrams illustrating an example of forming traffic packets at the base station of Fig. 5;

Fig. 7 is a block diagram showing a mobile station, to which the CDMA communications method in accordance with the present invention is applied;

Figs. 8A - 8E are schematic diagrams illustrating receiving operation at the mobile station of Fig. 7; and

Figs. 9A - 9F are schematic diagrams illustrating another example of forming traffic packets at the base station of Fig. 5.

[0035] Non-limiting embodiments of the invention will now be described with reference to the accompanying drawings.

[0036] Figs. 2A - 2D show the idea of the CDMA transmission method in accordance with the present invention. In the present invention, a fundamental transmission rate f_b bps is determined such that it is a few times greater than a voice transmission rate which has been conventionally used as the fundamental transmission rate. For example, a transmission rate of 32 kbps, which is four times greater than the conventional transmission rate of 8 kbps, is selected as the fundamental transmission rate. A frame of the fundamental transmission rate includes a synchronizing word SW, and a traffic channel TCH. A spectrum-spread wideband signal is generated by increasing the fundamental transmission rate by a factor of the processing gain (bandwidth spreading factor) through the primary and secondary modulations.

[0037] When the transmission rate of data is lower than the fundamental transmission rate fb bps, such as a low transmission rate coded voice, the original traffic channel TCH in a frame of the fundamental transmission rate is thinned out as shown in Figs. 2B and 2C, where the length of a frame is indicated by T. Figs. 2B and 2C illustrate cases when data are transmitted at a transmission rate $(f_b/2)$ bps, or half the fundamental transmission rate f_b bps. In Fig. 2B, the latter half of the traffic channel TCH is emptied, and in Fig. 2C, the traffic channel TCH

is divided into eight portions, and portions at even positions are cleared. These portions in the frame other than those used to transmit data are called vacant portions, in which no data are transmitted. The vacant portions can be arranged in many other ways, as well.

[0038] In the CDMA method which transmits a signal after spreading it into a wideband signal by a PN (Pseudo-noise) code or a Gold code, the capacity in terms of the number of subscribers per unit bandwidth is determined by interference power including noise power. In this embodiment, since data whose transmission rate is lower than the fundamental transmission rate are transmitted by thinning out the traffic channel TCH in a frame to make vacant portions, and a signal is not transmitted in the vacant portions, the interference on the other channels is reduced. For example, the interference power on the other channels due to the transmission signal of Figs. 2B and 2C is reduced to half the power of a frame which is not thinned out. As a result, the capacity in terms of the number of subscribers can be doubled. In other words, the number of subscribers is automatically increased at a low transmission rate as compared with the number of subscribers at the fundamental transmission rate. In this case, the fundamental transmission rate is twice the coded voice rate, and hence, the system of the present invention requires a double bandwidth of the conventional CDMA system. Accordingly, the capacity is the same as that of the conventional system. No disadvantage is seen.

[0039] On the other hand, when the transmission rate of data is higher than the fundamental transmission rate f_b bps, such as $4f_b$ bps as shown in Fig. 2D, for example, a plurality of (four in this case) different spreading codes are used to carry out the parallel transmission of individual channels. In this case, since the fundamental transmission rate is set higher than the conventional one (four times higher in this case), the number of channels required is reduced from 16 channels to 4 channels. Since the number of channels of the parallel transmission is reduced, the scale of a modulation circuit at the transmission side, and that of a demodulation circuit at the receiving side are reduced as compared with those of the conventional system.

[0040] Fig. 3 shows an embodiment of a transmitter of a base station for implementing the method in accordance with the present invention.

[0041] Each of n frame generation circuits 11_1 - 11_n (n is a positive integer) generates frames, each of which includes a synchronizing word and a traffic channel as shown in Figs. 2A - 2D, for each input data. The frame generation circuit 11_k (k = 1 - n) has three input terminals: an input terminal 12_k, to which data of the fundamental transmission rate fb bps are inputted, an input terminal connected to the output terminal of a TCH (traffic channel) frame thin-out circuit 13_k, and an input terminal connected to a k-th one of the n output terminals of a serial-to-parallel converter 14 which converts data, whose transmission rate is ifb bps (i is an integer greater

than one and equal to or less than n), into i parallel data.

[0042]   Each TCH frame thin-out circuit 13_k has an input terminal 15_k, to which data of an f_b/m bps (m is an integer greater than 1) transmission rate are applied, and converts the input data into thinned-out TCH data which are discretely inserted into the traffic channel TCH of a frame in a time division fashion as shown in Figs. 2B and 2C. Data of an if$_b$ bps transmission rate are inputted to the serial-to-parallel converter 14 through an input terminal 16. The data supplied to the input terminals 12_1 - 12_n, 15_1 - 15_n, and 16 are controlled at the preceding stage, so that only one of the three input terminals of the frame generation circuit 11_1 - 11_n is provided with the input data.

[0043]   The serial-to-parallel converter 14 receives data of an ifb bps transmission rate, converts them into i sets of parallel data, each of which has the fundamental transmission rate fb bps, and distributes each set to each one of the frame generation circuits 11_1 - 11_i.

[0044]   The output of the frame generation circuit 11_k is supplied to a primary modulation circuit 17k, and is converted into two signals (in-phase signal I and quadrature signal Q) in accordance with the modulation method (QPSK, for example). The two signals produced from the primary modulation circuit 17_k are supplied to complex multiplier 19_k, where the two signals are each multiplied by a spreading code supplied from a spreading code generator 18_k, and are spectrum spread. The spreading code generators 18_1 - 18_n generate spreading codes different from each other. All the I signals which are spectrum spread and outputted from the complex multipliers 19_1 - 19_n are added by an adder 21_I, and all the Q signals which are spectrum spread and outputted from the complex multipliers 19_1 - 19_n are added by an adder 21_Q. The outputs of the adders 21_I and 21_Q are converted into analog signals by D/A converters 22_I and 22_Q, respectively. After that, the analog signals, which are passed through low-pass filters 23_I and 23_Q, are inputted to a quadrature modulator 24, which quadrature-modulates an intermediate frequency signal from an oscillator 25 by the input signals. The modulated signal is passed through a band-pass filter 26, amplified by an amplifier 27, inputted to a mixer 28, and frequency-mixed with a carrier signal from an oscillator 29. The output of the mixer 28 is passed through a bandpass filter 31, power-amplified by an amplifier 32, outputted to an output terminal 33, and is radiated from an unshown antenna as an electric wave.

[0045]   Fig. 4 shows an embodiment of a receiver receiving a signal transmitted from the transmitter of Fig. 3. The received signal at an input terminal 41 is passed through a bandpass filter 42, amplified by an amplifier 43, and is frequency-mixed with a signal from an oscillator 45 by a mixer 44. The mixed output is passed through a bandpass filter 46, so that the intermediate frequency component is passed. The intermediate frequency signal is amplified by an automatic gain control amplifier 47 to a signal whose level is substantially con-

stant. The amplified output is converted into baseband I and Q signals by a quadrature detector 48 using a signal from an oscillator 49. The I and Q signals are passed through low-pass filters 51_I and 51_Q, and inputted to A/D converters 52_I and 52_Q which convert them into digital signals, respectively. The outputs of the A/D converters 52_I and 52_Q are divided into n signals by a signal distribution circuit 53_I and 53_Q, and are inputted to n matched filters 54_1 - 54_n, respectively. The matched filters 54_1 - 54_n take correlations between the input signals and codes associated with n spreading codes at the transmitter side, and spectrum-despread the input signals. The respective matched filters separate multipath components having different time delays.

[0046]   RAKE demodulators 55_1 - 55_n, receiving the output of the matched filters 54_1 - 54_n, weight and add the separated multipath components coherently, and demodulate the added result. The output of the RAKE demodulator 55_1 is supplied to a rate conversion circuit 56 for data communications of the rate less than or equal to f_b bps. The rate conversion circuit 56 outputs the data in continuous mode. Thus, when the transmission rate of the received signal is f_b/m bps, where m is an integer equal to or greater than one, demodulated data is obtained at the output terminal 59. On the other hand, when the transmission rate of the received signal is if$_b$ bps, signals of the individual channels, each having a transmission rate of f_b bps, are converted into a serial signal of if$_b$ bps by the parallel-to-serial converter 57, and the serial signal is outputted from an output terminal 58. A mobile receiver which provides data communications whose rate is less than or equal to f_b bps requires only one set of demodulation circuit (a matched filter plus a RAKE demodulator), thereby making the circuit scale small.

[0047]   There are two methods for thinning out the traffic channel TCH. A first method makes the transmitting timings of the frames random at each base station. A second method makes the arrangement of the data in a frame random, and assigns the random arrangements to respective users. The random arrangement can be prepared, for example, from the user number and random patterns. According to the first method, the base station transmits the information on TCH (traffic channel) rate to the mobile station so that a mobile station can properly pick up data in the traffic channel. According to the second method, it is sufficient for a base station to provide a mobile station with information on the arrangement pattern corresponding to the transmission rate.

[0048]   Fig. 5 shows a major portion of a base station which employs the first method. In this embodiment, the transmission rate of data inputted to channel input terminals 111_1 - 111_n is 1/N of the fundamental transmission rate, where N is a positive integer. In other words, the data have a temporal length N times longer than the same amount of data of the fundamental transmission rate. The data are supplied to TCH frame thin-out cir-

cuits 112_1 - 112_n, and are time-compressed by a factor of N (N = 4 in Figs. 6A - 6C) at every time period T to form packets, where T is the length of a frame of the fundamental transmission rate. These packets undergo the primary modulation in primary modulators 113_1 - 113_n, and then the spectrum-spreading modulation in secondary modulators (spreading modulators) 114_1 - 114_n, thereby being converted into wideband signals. The spreading modulators 114_1 - 114_n receive different spreading codes C_1-C_n from spreading code generators 115_1 - 115_n.

[0049] In this case, the packets P_1 - P_n generated by the TCH frame thin-out circuits 112_1 - 112_n have random time relationships with each other as shown in Figs. 6A - 6C. This is allowable because the plurality of packets are each associated with different spreading codes, and hence, the packets can be separated at the receiving side even if they overlap with each other temporally. Accordingly, as soon as individual channel signals are inputted, they can be formed into packets without any time adjustments.

[0050] Base stations have, in addition to the traffic channels, common control channels for transmitting control information such as identification information of respective base stations, and paging information. Furthermore, a weather forecast, and other broadcasting information can be transmitted as required. The information on the common channel is spread by spreading code C_c different from the spreading codes C_1 - C_n for communications, and is transmitted from common control channel transmitting portion 116. The outputs of the spreading modulators 114_1 - 114_{n+1} are combined, supplied to an output terminal 117, and transmitted from a transmitter not shown in Fig. 5 as an electric wave.

[0051] Fig. 7 shows a major portion of a mobile station, to which the present invention is applied. Electric waves from base stations are received by a receiving portion not shown in Fig. 7, and are inputted to an input terminal 121 after converted into an intermediate frequency signal. The intermediate frequency signal is despread by a spreading code assigned to the communication, for example, by the spreading code C_2. The despread output undergoes the primary demodulation by a primary demodulator 124. The demodulated output is inputted to a frame detector 125 which detects the period T and temporal positions of packets, and outputs frame pulses as shown in Fig. 8A. The frame pulses are supplied to a controller 126 which controls a switch 127 so that packets P_2 obtained by the despreading using the spreading code C_2 are supplied to a rate conversion circuit 128. The rate conversion circuit 128 expands the packets P_2 by a factor of N. Thus, the transmission data, which is inputted to the channel input terminal 111_2, and whose transmission rate is 1/N of the fundamental transmission rate, is outputted from an output terminal 129.

[0052] The controller 126 controls the spreading code generator 123 so that the spreading code (C_c, for example) associated with the common control channel of the current base station or each of the neighboring base stations is outputted from the spreading code generator 123 during a portion (for example, portion T_{03} as shown in Figs. 8D and 8E) other than the portion T_{01} which receives the packet P_2 in each frame as shown in Fig. 8B. In addition, the controller 126 changes the switch 127 so that the output terminal of the primary demodulator 124 is connected to a side of a received power measurement circuit 131 and a common control data demodulator 132. Accordingly, as shown in Fig. 8E, during the portion T_{03} in a frame, the common control channel from a base station is received, and the received power is measured by the received power measurement circuit 131. Thus, the received power measurement is carried out in the portion T_{03} of each frame by switching the spreading code to one of the spreading codes associated with the common control channels of the neighboring base stations. Then, the base station having the common control channel which is associated with the maximum received power is selected as the base station, to which the communication is to be switched, by a base station decision circuit 133 (which is usually included in the controller 126).

[0053] Changing the base station is required for continuous communication when measurement of the power of the received signal from the current base station is carried out in the portions T_{01}, and the receiving quality degrades below an allowable level during the communication. In this case, the mobile station provides, through the traffic channel, the current base station with information on the base station, to which the communication is to be switched, so that the switching to the new base station is performed. The channel switching operation of the traffic channel can be achieved in the same manner as a conventional method. The present invention differs from the conventional method in that the decision of the base station, to which the communication is to be switched, is made at the mobile station side, whereas the conventional method decides it at the base station side.

[0054] A common control data demodulator 132 can demodulate various broadcasting data or a paging during communication by supplying the despreading circuit 122 with the spreading code associated with the common control channel during a portion (T_{03}, for example) other than the traffic packet receiving portion T_{01}. Measuring of the received power and reception of the common control data can be carried out in the same frame. For example, two identical length vacant portions T_{03} and T_{04} other than the packet receiving portion T_{01} in a frame are selected, and one of them is used to measure the received power by providing the despreading circuit 122 with the spreading code associated with the common control channel from a neighboring base station.

[0055] The data to be transmitted from the mobile station have a transmission rate of 1/N of the fundamental transmission rate. A TCH frame thin-out circuit 136 of Fig. 7 receives the data through an input terminal 135,

and temporally compresses the data by a factor of N every frame interval T to form packets as shown in Fig. 8C. The packets are assigned to a vacant portion (for example, T_{02}) other than the receiving portions T_{01} and T_{03} by the controller 126. The packets undergo the primary modulation by a primary modulator 137. The primary modulation output is spectrum-spread modulated by a secondary modulator (spread modulator) 138 using a spreading code C_{21} from a spreading code generator 139, and the spectrum-spread wideband signal is transmitted through a terminal 141, a transmitter not shown in Fig. 7, and an antenna for both transmitting and receiving. Since the transmit and receive portions are separated, the same radio carrier frequency can be used for transmitter and receiver. However, if different frequencies are used, transmitting and receiving can be performed at the same time (for example, at the portion T_{01}).

[0056] Since the data is transmitted after time-compressed, data whose transmission rate is from 1/N to (N-1)/N of the fundamental transmission rate can be transmitted by using a single spreading code and by setting N equal to or greater than 3. One portion is used for receiving the broadcasting data and the remaining (N-1) portions can be used for communication.

[0057] Figs. 9A - 9F illustrate the relationships between frames and packets when the compression ratio N = 8. Fig. 9B shows the case where data whose transmission rate is 1/8 of the fundamental transmission rate is inputted to the channel input terminal 111_1 of the transmitter of Fig. 5. The data corresponding to a frame is time-compressed to a packet P_1 whose length is T/8, and is transmitted. Fig. 9C shows the case where data whose transmission rate is 1/2 of the fundamental transmission rate is inputted to the channel input terminal 111_2 of the transmitter. The data corresponding to a frame is time-compressed to a packet P_2 whose length is T/2, and is transmitted. Fig. 9D shows the case where data whose transmission rate is 1/8 of the fundamental transmission rate is inputted to the channel input terminal 111_3 of the transmitter. The data corresponding to a frame is time-compressed to a packet P_3 whose length is T/8, and is transmitted. Fig. 9E shows the case where data whose transmission rate is 1/4 of the fundamental transmission rate is inputted to the channel input terminal 111_4 of the transmitter. The data corresponding to a frame is time-compressed to a packet P_4 whose length is T/4, and is transmitted.

[0058] In this case, although the spreading codes C_1-C_n inputted to the spreading modulators 114_1 - 114_n differ from each other, the same spreading code may be consistently used for data inputted to the same channel input terminal, or other spreading codes may be used. For example, the spreading code C_2 may be consistently used for the packet P_2 of Fig. 9C, or the spreading code may be changed for each one of the T/N long portions. In addition, the packet P_2 may be divided into two packets P_{21} and P_{22} as shown in Fig. 9F. By thus divid-

ing the transmission data in a frame, an advantage of smoothing the interference is obtained.

[0059] The division of the transmission data in a frame can be carried out by the following procedure.

(1) Store the input data into a memory in the TCH frame thin-out circuit.
(2) Read data in the memory at the fundamental transmission rate in the designated time duration (= T/N).

[0060] The packets shown in Figs. 9B - 9F are received by a mobile station, and restored to the original data by the rate conversion. Thus, even if the transmission rate of the input data is varied, the data can be transmitted as long as its transmission rate is equal to or less than the fundamental transmission rate. In addition, a mobile station can receive the common control data addressed to itself or to other mobile stations in a vacant portion in each frame by switching the spreading code for the despreading, at timings as indicated by broken lines in Figs. 9C - 9F, for example.

[0061] Although data whose transmission rate is lower than the fundamental transmission rate is transmitted through a single channel in this embodiment, the number of channels is not restricted to one. For example, although the packet P_2 in Fig. 9C is transmitted using four T/N long portions in the frame of a single channel, it can be transmitted by distributing the packet to four channels. In this case, each channel transmits the data using one portion in a frame.

[0062] The present invention has been described in detail with respect to various embodiments, and it will now be apparent from the foregoing to those skilled in the art that changes and modifications may be made without departing from the scope of the invention as defined in the appended claims.

Claims

1. A CDMA (Code Division Multiple Access) communications method for transmitting transmission data through one or more channels between base stations and a mobile station, said method comprising the steps of:

generating a frame including at least a part of said transmission data;
performing a primary modulation of said frame to produce a primary modulation signal;
performing a secondary modulation of said primary modulation signal using a spreading code, to produce a secondary modulated wideband signal, said spreading code being different for each of said channels; and
transmitting said wideband signal using a carrier;

characterised In that said step of generating a frame comprises the step of time compressing said transmission data by a factor of N at every time period T when the transmission rate of said transmission data is 1/N of a predetermined transmission rate, where N is an integer greater than one, and T is the length of a frame at said predetermined transmission rate, thereby providing said frame with a vacant portion when a transmission rate of said transmission data is lower than said predetermined transmission rate, said vacant portion having no data to be transmitted.

2. The CDMA communications method as claimed in claim 1, **characterised In that** said step of generating a frame comprises the steps of:

    predetermining said predetermined transmission rate to be higher than a minimum transmission rate; and
    determining a frame length such that the frame includes no vacant portion when data is transmitted at said predetermined transmission rate.

3. The CDMA communication method as claimed in claim 2, **characterised In that** said minimum transmission rate is a rate of transmitting a voice signal.

4. The CDMA communications method as claimed in claim 2, further **characterised by** comprising the step of generating a plurality of frames to be assigned to a plurality of said channels when data is transmitted at a rate higher than said predetermined transmission rate.

5. The CDMA communications method as claimed in claim 1, further **characterised by** comprising the steps of:

    obtaining said primary modulation signal by receiving a wideband signal associated with one of said channels, and by despreading said wideband signal using a spreading code; and restoring said transmission data by primarily demodulating said primary modulation signal obtained at the step of obtaining, and by time expanding the demodulation output by a factor of the N.

6. The CDMA communications method as claimed in claim 5, further **characterised by** comprising the steps of:

    measuring received power of a common control channel signal transmitted from a base station other than a base station with which the mobile station is communicating, by switching said spreading code during a time period corre-

sponding to said vacant portion In said frame; and
deciding during communications a base station to which the communication is to be switched in accordance with said received power.

7. The CDMA communications method as claimed in claim 5, further **characterised by** comprising the steps of:

    receiving common control channel data transmitted from at least one of said base stations during a time period corresponding to said vacant portion of said frame by switching said spreading code; and
    demodulating said common control channel data.

8. The CDMA communications method as claimed in claim 6, **characterised In that** said step of generating a frame comprises the step of generating a frame from said transmission data by using a plurality of T/N long portions in said frame, said transmission data having a transmission rate equal to or less than (N-1)/N times of said predetermined transmission rate of said channel, where the N is an integer equal to or greater than three and the T is the length of a frame at said predetermined transmission rate.

9. A CDMA (Code Division Multiple Access) communications apparatus for transmitting transmission data through one or more channels between base stations and a mobile station, said apparatus comprising:

    means (11, 13) for generating a frame including at least a part of said transmission data;
    means (17) for performing a primary modulation of said frame to produce a primary modulation signal;
    means (19) for performing a secondary modulation of said primary modulation signal using a spreading code (18), to produce a secondary modulated wideband signal, said spreading code being different for each of said channels; and
    means (28) for transmitting said wideband signal using a carrier;

    characterised In that said means (11, 13) for generating a frame comprises means (13) for time compressing said transmission data by a factor of N at every time period T when the transmission rate of said transmission data is 1/N of a predetermined transmission rate, where N is an integer greater than one, and T is the length of a frame at said predetermined transmission rate, thereby providing

said frame with a vacant portion when a transmission rate of said transmission data is lower than said predetermined rate, said vacant portion having no data to be transmitted.

10. The CDMA communications apparatus as claimed in claim 9, **characterised in that** said means (11, 13) for generating a frame comprises means for predetermining said predetermined transmission rate to be higher than a minimum transmission rate and means for determining a frame length such that the frame includes no vacant portion on data transmission at said predetermined transmission rate.

11. The CDMA communication apparatus as claimed in claim 10, **characterised in that** said minimum transmission rate is a rate of transmitting a voice signal.

12. The CDMA communications apparatus as claimed in claim 10, further **characterised by** comprising means for generating a plurality of frames to be assigned to a plurality of said channels when data is transmitted at a rate higher than said predetermined transmission rate.

13. The CDMA communications apparatus as claimed in claim 9, further **characterised by** comprising:

means (54, 55) for obtaining said primary modulation signal by receiving a wideband signal associated with one of said channels, and by despreading said wideband signal using a spreading code; and
means (56) for restoring said transmission data by primarily demodulating said primary modulation signal obtained by said means for obtaining, and by time expanding the demodulation output by a factor of N.

14. The CDMA communications apparatus as claimed in claim 13, further **characterised by** comprising:

means (131) for measuring received power of a common control channel signal transmitted from a base station other than a base station with which the mobile station is communicating, by switching said spreading code during a time period corresponding to said vacant portion in said frame; and
means (133) for deciding during communications a base station to which the communication is to be switched in accordance with said received power.

15. The CDMA communications apparatus as claimed in claim 13, further **characterised by** comprising:

means (122 to 126) for receiving common control channel data transmitted from at least one of said base stations during a time period corresponding to said vacant portion of said frame by switching said spreading code; and
means (132) for demodulating said common control channel data.

16. The CDMA communications apparatus as claimed in claim 14, **characterised in that** said means for generating a frame comprises means for generating a frame from said transmission data by using a plurality of T/N long portions in said frame, said transmission data having a transmission rate equal to or less than (N-1)/N times of said predetermined transmission rate of said channel, where the N is an integer equal to or greater than three and the T is the length of a frame at said predetermined transmission rate.

Patentansprüche

1. CDMA- (Code-Multiplex-Zugriffs-) Kommunikationsverfahren zur Übertragung von Übertragungsdaten über einen oder mehrere Kanäle zwischen Basisstationen und einer Mobilstation, wobei das Verfahren die Schritte aufweist:

Erzeugen eines zumindest einen Teil der Übertragungsdaten enthaltenden Rahmens;
Durchführen einer primären Modulation des Rahmens zum Erstellen eines primären Modulationssignals;
Durchführen einer sekundären Modulation des primären Modulationssignals unter Verwendung eines Spreizcodes, um ein sekundäres moduliertes Breitbandsignal zu erstellen, wobei der Spreizcode für jeden der Kanäle unterschiedlich ist; und
Übertragen des Breitbandsignals unter Verwendung eines Trägers;

dadurch gekennzeichnet, dass

der Schritt des Erzeugens eines Rahmens den Schritt des Zeitkomprimierens der Übertragungsdaten um einen Faktor von N für jede Zeitperiode T aufweist, wenn die Übertragungsrate der Übertragungsdaten das 1/N -fache einer vorbestimmten Übertragungsrate ist, wobei N eine ganze Zahl größer als 1 ist, und T die Länge eines Rahmens bei der vorbestimmten Übertragungsrate ist, wodurch der Rahmen mit einem freien Abschnitt versehen wird, wenn eine Übertragungsrate der Übertragungsdaten geringer als die vorbestimmte Übertragungsrate ist, wobei der freie Abschnitt

keine zu übertragenden Daten hat.

2. CDMA-Kommunikationsverfahren nach Anspruch 1,

   dadurch gekennzeichnet, dass

   der Schritt des Erzeugens eines Rahmens die Schritte aufweist:

   Vorbestimmen der vorbestimmten Übertragungsrate, um höher als eine minimale Übertragungsrate zu sein; und
   Bestimmen einer Rahmenlänge derart, dass der Rahmen keinen freien Abschnitt enthält, wenn Daten mit der vorbestimmten Übertragungsrate übertragen werden.

3. CDMA-Kommunikationsverfahren nach Anspruch 2,

   dadurch gekennzeichnet, dass

   die minimale Übertragungsrate eine Rate zur Übertragung eines Sprachsignals ist.

4. CDMA-Kommunikationsverfahren nach Anspruch 2,

   zudem gekennzeichnet durch

   den Schritt des Erzeugens einer Vielzahl von Rahmen, die einer Vielzahl der Kanäle zuzuweisen sind, wenn Daten mit einer höheren Rate als der vorbestimmten Übertragungsrate übertragen werden.

5. CDMA-Kommunikationsverfahren nach Anspruch 1,

   zudem gekennzeichnet durch die Schritte:

   Gewinnen des primären Modulationssignals **durch** Empfangen eines einem der Kanäle zugeordneten Breitbandsignals, und **durch** Entspreizen des Breitbandsignals unter Verwendung eines Spreizcodes; und
   Wiederherstellen der Übertragungsdaten **durch** primäres Demodulieren des primären Modulationssignals, welches bei dem Schritt des Gewinnens gewonnen wurde, und **durch** Zeitexpansion der Demodulationsausgabe um einen Faktor von N.

6. CDMA-Kommunikationsverfahren nach Anspruch 5,

   zudem gekennzeichnet durch:

   Messen empfangener Leistung eines gemeinsamen Steuerungskanal-Signals, welches von einer Basisstation übertragen wird, die von einer Basisstation verschieden ist, mit der die

Mobilstation kommuniziert, indem der Spreizcode während einer dem freien Abschnitt in dem Rahmen entsprechenden Zeitperiode umgeschaltet wird; und
Treffen einer Entscheidung während einer Kommunikation entsprechend der empfangenen Leistung bezüglich einer Basisstation, zu der die Kommunikation umzuschalten ist.

7. CDMA-Kommunikationsverfahren nach Anspruch 5,

   zudem gekennzeichnet durch die Schritte:

   Empfangen gemeinsamer Steuerungskanal-Daten, die von zumindest einer der Basisstationen während einer dem freien Abschnitt des Rahmens entsprechenden Zeitperiode übertragen werden, indem der Spreizcode umgeschaltet wird; und
   Demodulieren der gemeinsamen Steuerungskanal-Daten.

8. CDMA-Kommunikationsverfahren nach Anspruch 6,

   dadurch gekennzeichnet, dass

   der Schritt des Erzeugens eines Rahmens den Schritt des Erzeugens eines Rahmens aus Übertragungsdaten unter Verwendung einer Vielzahl von T/N langen Abschnitten in dem Rahmen umfasst, wobei die Übertragungsdaten eine Übertragungsrate gleich oder kleiner als das $(N-1)/N$ -fache der vorbestimmten Übertragungsrate des Kanals haben, wobei N eine ganze Zahl gleich oder größer als drei und T die Länge eines Rahmens bei der vorbestimmten Übertragungsrate ist.

9. CDMA- (Code-Multiplex-Zugriffs-) Kommunikationsgerät zur Übertragung von Übertragungsdaten über einen oder mehrere Kanäle zwischen Basisstationen und einer Mobilstation, wobei das Gerät aufweist:

   Einrichtungen (11, 13) zur Erzeugung eines zumindest einen Teil der Übertragungsdaten enthaltenden Rahmens;
   Einrichtungen (17) zum Durchführen einer primären Modulation des Rahmens zum Erstellen eines primären Modulationssignals;
   Einrichtungen (19) zum Durchführen einer sekundären Modulation des primären Modulationssignals unter Verwendung eines Spreizcodes (18), um ein sekundäres moduliertes Breitbandsignal zu erstellen, wobei der Spreizcode für jeden der Kanäle unterschiedlich ist; und
   Einrichtungen (28) zum Übertragen des Breitbandsignals unter Verwendung eines Trägers;

dadurch gekennzeichnet, dass

die Einrichtungen (11, 13) zur Erzeugung eines Rahmens Mittel (13) aufweisen zur Zeitkomprimierung der Übertragungsdaten um einen Faktor von N für jede Zeitperiode T, wenn die Übertragungsrate der Übertragungsdaten das 1/N - fache einer vorbestimmten Übertragungsrate ist, wobei N eine ganze Zahl größer als Eins und T die Länge eines Rahmens bei der vorbestimmten Übertragungsrate ist, wodurch der Rahmen mit einem freien Abschnitt versehen wird, wenn eine Übertragungsrate der Übertragungsdaten niedriger als die vorbestimmte Rate ist, wobei der freie Abschnitt keine zu übertragenden Daten hat.

10. CDMA-Kommunikationsgerät nach Anspruch 9, **dadurch gekennzeichnet, dass**

die Einrichtungen (11, 13) zum Erzeugen eines Rahmens Mittel zum Vorbestimmen der vorbestimmten Übertragungsrate aufweisen, um höher als eine minimale Übertragungsrate zu sein, und Mittel zum derartigen Bestimmen einer Rahmenlänge aufweisen, dass der Rahmen keinen freien Abschnitt bei einer Datenübertragung mit der vorbestimmten Übertragungsrate enthält.

11. CDMA-Kommunikationsgerät nach Anspruch 10, **dadurch gekennzeichnet, dass**

die minimale Übertragungsrate eine Rate zur Übertragung eines Sprachsignals ist.

12. CDMA-Kommunikationsgerät nach Anspruch 10, **zudem gekennzeichnet durch**

Einrichtungen zum Erzeugen einer Vielzahl von Rahmen, die einer Vielzahl der Kanäle zuzuweisen sind, wenn Daten mit einer höheren Rate als der vorbestimmten Übertragungsrate übertragen werden.

13. CDMA-Kommunikationsgerät nach Anspruch 9, **zudem gekennzeichnet durch:**

Einrichtungen (54, 55) zur Gewinnung des primären Modulationssignals **durch** Empfangen eines einem der Kanäle zugeordneten Breitbandsignals, und **durch** Entspreizen des Breitbandsignals unter Verwendung eines Spreizkodes; und
Einrichtungen (56) zum Wiedergewinnen der Übertragungsdaten **durch** primäres Demodulieren des primären Modulationssignals, welches **durch** die Einrichtungen zur Gewinnung

gewonnen wurde, und **durch** Zeitexpansion der Demodulationsausgabe um einen Faktor von N.

14. CDMA-Kommunikationsgerät nach Anspruch 13, **zudem gekennzeichnet durch:**

Einrichtungen (131) zur Messung empfangener Leistung eines gemeinsamen Steuerungskanal-Signals, welches von einer Basisstation übertragen wurde, die von einer Basisstation verschieden ist, mit der die Mobilstation kommuniziert, **durch** Umschalten des Spreizcodes während einer dem freien Abschnitt in dem Rahmen entsprechenden Zeitperiode; und Einrichtungen (133) zum Treffen einer Entscheidung während einer Kommunikation gemäß der empfangenen Leistung bezüglich einer Basisstation, zu der die Kommunikation umzuschalten ist.

15. CDMA-Kommunikationsgerät nach Anspruch 13, **zudem gekennzeichnet durch**

Einrichtungen (122 bis 126) zum Empfangen gemeinsamer Steuerungskanal-Daten, die von zumindest einer der Basisstationen während einer dem freien Abschnitt des Rahmens entsprechenden Zeitperiode übertragen wurden, **durch** Umschalten des Spreizcodes; und Einrichtungen (132) zur Demodulation der gemeinsamen Steuerungskanal-Daten.

16. CDMA-Kommunikationsgerät nach Anspruch 14, **dadurch gekennzeichnet, dass**

die Einrichtungen zur Erzeugung eines Rahmens Mittel aufweisen zum Erzeugen eines Rahmens aus den Übertragungsdaten unter Verwendung einer Vielzahl von T/N langen Abschnitten in dem Rahmen, wobei die Übertragungsdaten eine Übertragungsrate gleich oder kleiner als das (N-1)/N -fache der vorbestimmten Übertragungsrate des Kanals haben, wobei N eine ganze Zahl gleich oder größer als drei und T die Länge eines Rahmens bei der vorbestimmten Übertragungsrate ist.

Revendications

1. Procédé de communication CDMA (Accès Multiple par Répartition de Code) destiné à transmettre des données de transmission par l'intermédiaire d'un ou plusieurs canaux entre des stations de base et une station mobile, ledit procédé comprenant les étapes consistant à :

produire une trame comportant au moins une partie des données de transmission ;

effectuer une modulation principale de la trame afin de produire un signal de modulation principale ;

effectuer une modulation secondaire du signal de modulation principale en utilisant un code d'étalement, afin de produire un signal secondaire modulé à large bande, le code d'étalement étant différent pour chacun des canaux ; et

transmettre le signal à large bande au moyen d'une porteuse ;

caractérisé en ce que l'étape de production d'une trame comprend l'étape consistant à comprimer temporellement les données de transmission d'un facteur égal à N lors de chaque période de temps T lorsque le débit de transmission des données de transmission est égal à 1/N d'un débit de transmission déterminé à l'avance, N étant un entier supérieur à un, et T étant la longueur d'une trame au débit de transmission déterminé à l'avance, ce qui permet de produire la trame avec une partie vacante lorsque le débit de transmission des données de transmission est inférieur au débit de transmission déterminé à l'avance, la partie vacante n'ayant pas de données à transmettre.

2. Procédé de communication CDMA suivant la revendication 1, caractérisé en ce que l'étape de production d'une trame comprend les étapes consistant à:

déterminer à l'avance le débit de transmission déterminé à l'avance afin qu'il soit supérieur à un débit de transmission minimum ; et

déterminer une longueur de trame de telle façon que la trame ne contienne pas de partie vacante lorsque des données sont transmises au débit de transmission déterminé à l'avance.

3. Procédé de communication CDMA suivant la revendication 2, caractérisé en ce que le débit de transmission minimum est le débit de transmission d'un signal vocal.

4. Procédé de communication CDMA suivant la revendication 2, caractérisé en outre par le fait qu'il comprend l'étape consistant à produire une pluralité de trames devant être affectées à une pluralité des canaux lorsque des données sont transmises à un débit supérieur au débit de transmission déterminé à l'avance.

5. Procédé de communication CDMA suivant la revendication 1, caractérisé en outre par le fait qu'il comprend l'étape consistant à :

obtenir le signal de modulation principale en recevant un signal à large bande associé à l'un des canaux, et en désétalant le signal à large bande au moyen d'un code d'étalement ; et

régénérer les données de transmission en démodulant par démodulation principale ledit signal à modulation principale obtenu lors de l'étape d'obtention, et en décomprimant temporellement la sortie de la démodulation d'un facteur égal à N.

6. Procédé de communication CDMA suivant la revendication 5, caractérisé en outre par le fait qu'il comprend les étapes consistant à :

mesurer la puissance reçue d'un signal de canal de commande commun transmis par une station de base autre qu'une station de base avec laquelle la station mobile est en cours de communication, en commutant le code d'étalement pendant une période de temps correspondant à la partie vacante dans la trame ; et décider, pendant la communication, de la station de base vers laquelle la communication doit être commutée en fonction de la puissance reçue.

7. Procédé de communication CDMA suivant la revendication 5, caractérisé en outre par le fait qu'il comprend les étapes consistant à :

recevoir des données de canal de commande commun transmises par au moins l'une des stations de base pendant une période de temps correspondant à la partie vacante de la trame par commutation du code d'étalement ; et démoduler les données du canal de commande commun.

8. Procédé de communication CDMA suivant la revendication 6, caractérisé en ce que l'étape de production d'une trame comprend l'étape consistant à produire une trame à partir des données de transmission en utilisant une pluralité de parties de longueur égale à T/N dans cette trame, les données de transmission ayant un débit de transmission égal ou inférieur à (N-1)/N fois le débit de transmission déterminé à l'avance pour le canal, N étant un entier égal ou supérieur à trois et T étant la longueur d'une trame au débit de transmission déterminé à l'avance.

9. Appareil de communication CDMA (Accès Multiple par Répartition de Code) destiné à transmettre des données de transmission par l'intermédiaire d'un ou plusieurs canaux entre des stations de base et une station mobile, l'appareil comprenant :

un moyen (11, 13) destiné à produire une trame contenant au moins une partie des données de transmission ;

un moyen (17) destiné à effectuer une modulation principale de la trame afin de produire un signal à modulation principale ;

un moyen (19) destiné à effectuer une modulation secondaire du signal à modulation principale en utilisant un code d'étalement (18) afin de produire un signal à large bande modulé par modulation secondaire, le code d'étalement étant différent pour chacun des canaux ; et

un moyen (28) destiné à transmettre le signal à large bande au moyen d'une porteuse ;

caractérisé en ce que le moyen (11, 13) destiné à produire une trame comprend un moyen (13) destiné à comprimer temporellement les données de transmission d'un facteur égal à N lors de chaque période de temps T lorsque le débit de transmission des données de transmission est égal à 1/N d'un débit de transmission déterminé à l'avance, N étant un entier supérieur à un, et T étant la longueur d'une trame au débit de transmission déterminé à l'avance, afin de conférer ainsi à la trame une partie vacante lorsque le débit de transmission des données de transmission est inférieur au débit de transmission déterminé à l'avance, la partie vacante n'ayant pas de données à transmettre.

10. Appareil de communication CDMA suivant la revendication 9, caractérisé en ce que le moyen (11, 13) destiné à produire une trame comprend un moyen destiné à déterminer à l'avance le débit de transmission déterminé à l'avance afin qu'il soit supérieur à un débit de transmission minimum et un moyen destiné à déterminer une longueur de trame telle que la trame ne contienne pas de partie vacante lors de la transmission de données au débit de transmission déterminé à l'avance.

11. Appareil de communication CDMA suivant la revendication 10, caractérisé en ce que le débit de transmission minimum est le débit de transmission d'un signal vocal.

12. Appareil de communication CDMA suivant la revendication 10, caractérisé en outre par le fait qu'il comprend un moyen destiné à produire une pluralité de trames devant être affectées à une pluralité des canaux lorsque des données sont transmises à un débit supérieur au débit de transmission déterminé à l'avance.

13. Appareil de communication CDMA suivant la revendication 9, caractérisé en outre par le fait qu'il comprend :

un moyen (54, 55) destiné à obtenir le signal à modulation principale en recevant un signal à large bande associé à l'un des canaux, et en désétalant le signal à large bande en utilisant un code d'étalement ; et

un moyen (56) destiné à régénérer les données de transmission par démodulation principale du signal à modulation principale obtenu par le moyen d'obtention, et en décomprimant temporellement la sortie de démodulation d'un facteur égal à N.

14. Appareil de communication CDMA suivant la revendication 13, caractérisé en outre par le fait qu'il comprend :

un moyen (131) pour mesurer la puissance reçue d'un signal de canal de commande commun transmis par une station de base autre qu'une station de base avec laquelle la station mobile est en cours de communication, en commutant le code d'étalement pendant une période de temps correspondant à la partie vacante de la trame ; et

un moyen (133) pour décider, pendant la communication, de la station de base vers laquelle la communication doit être commutée en fonction de la puissance reçue.

15. Appareil de communication CDMA suivant la revendication 13, caractérisé en outre par le fait qu'il comprend :

un moyen (122 à 126) destiné à recevoir des données de canal de commande commun transmises par au moins l'une des stations de base pendant une période de temps correspondant à la partie vacante de la trame par commutation du code d'étalement ; et

un moyen (132) destiné à démoduler les données de canal de commande commun.

16. Appareil de communication CDMA suivant la revendication 14, caractérisé en ce que le moyen destiné à produire une trame comprend un moyen destiné à produire une trame à partir des données de transmission en utilisant une pluralité de parties de la trame de longueur égale à T/N, les données de transmission ayant un débit de transmission égal ou inférieur à (N-1)/N fois le débit de transmission déterminé à l'avance du canal, N étant un entier égal ou supérieur à trois et T étant la longueur d'une trame au débit de transmission déterminé à l'avance.

FIG.1A
(PRIOR ART)

FUNDAMENTAL
TRANSMISSION
RATE f_b bps

FIG.1B
(PRIOR ART)

$2f_b$ bps

(2-CHANNEL
MULTIPLEXING)
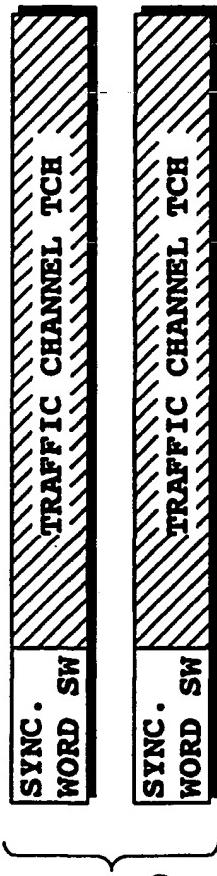
FIG.1C
(PRIOR ART)

$4f_b$ bps

(4-CHANNEL
MULTIPLEXING)
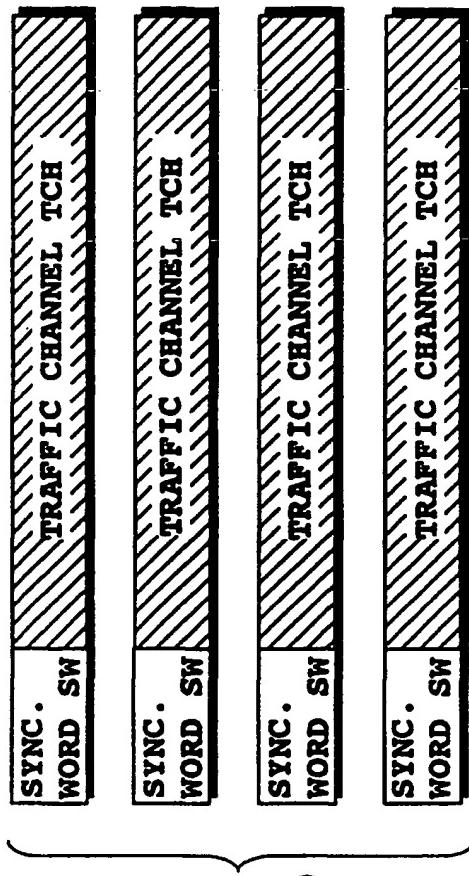
FIG.2A

FIG.2B

FIG.2C

FIG.2D

FUNDAMENTAL
TRANSMISSION
RATE fb bps

$f_b/2$ bps

$4f_b$ bps

(4-CHANNEL
MULTIPLEXING)

SYNC. WORD SW

TRAFFIC CHANNEL TCH

SYNC. WORD SW

TRAFFIC
CHANNEL TCH

SYNC. WORD SW

TRAFFIC
CHANNEL TCH

T

SYNC. WORD SW

TRAFFIC CHANNEL TCH

SYNC. WORD SW

TRAFFIC CHANNEL TCH

SYNC. WORD SW

TRAFFIC CHANNEL TCH

SYNC. WORD SW

TRAFFIC CHANNEL TCH
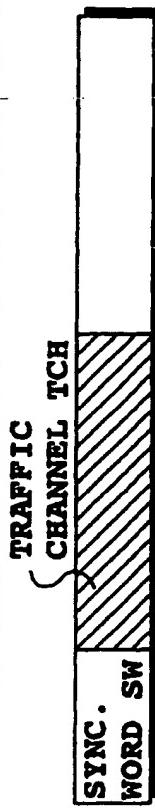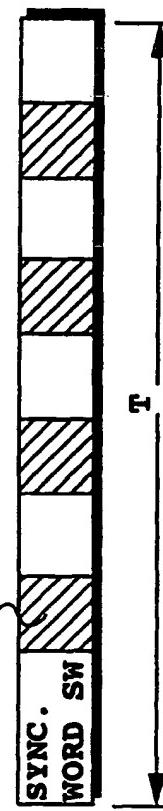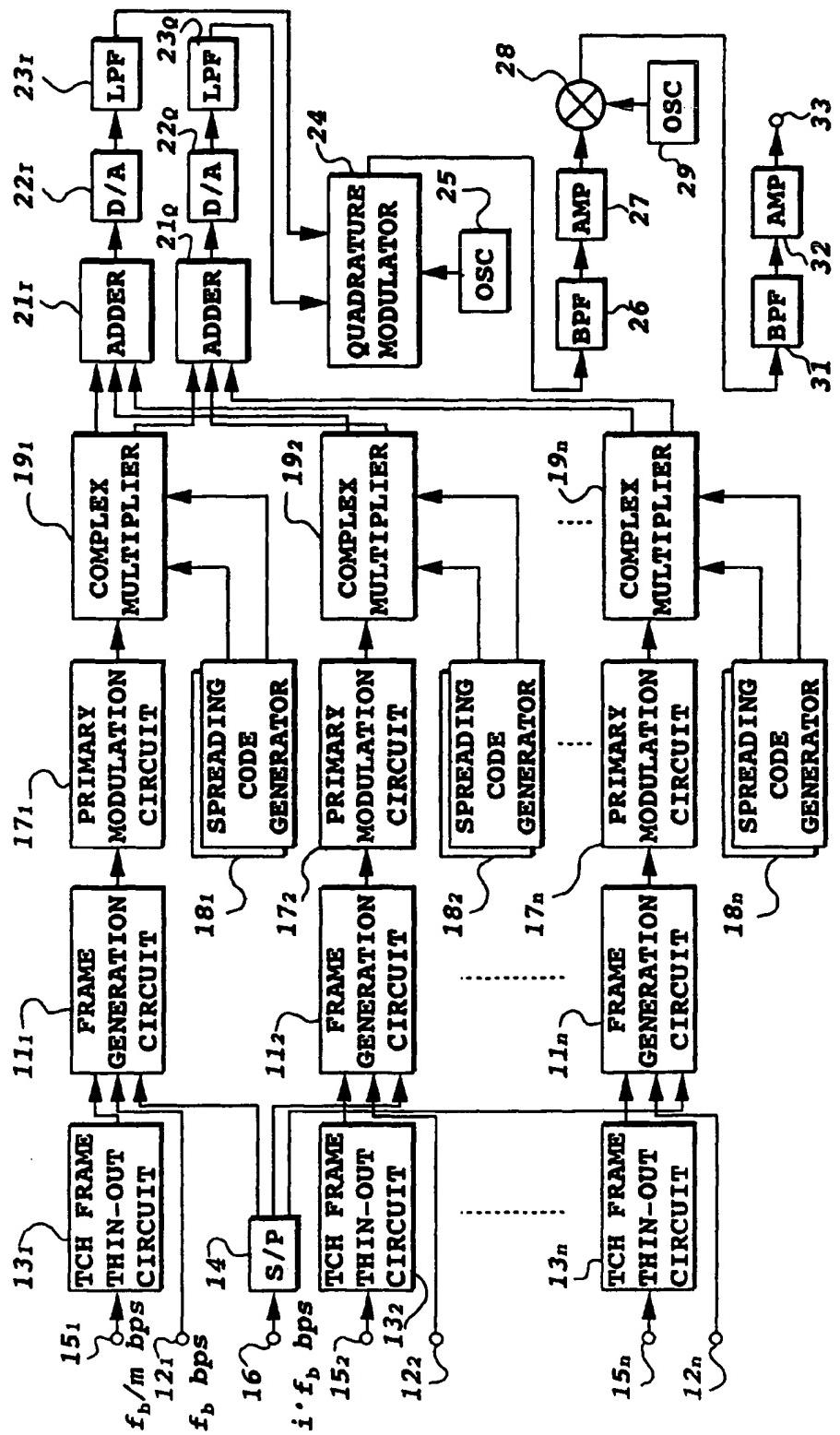
FIG.3
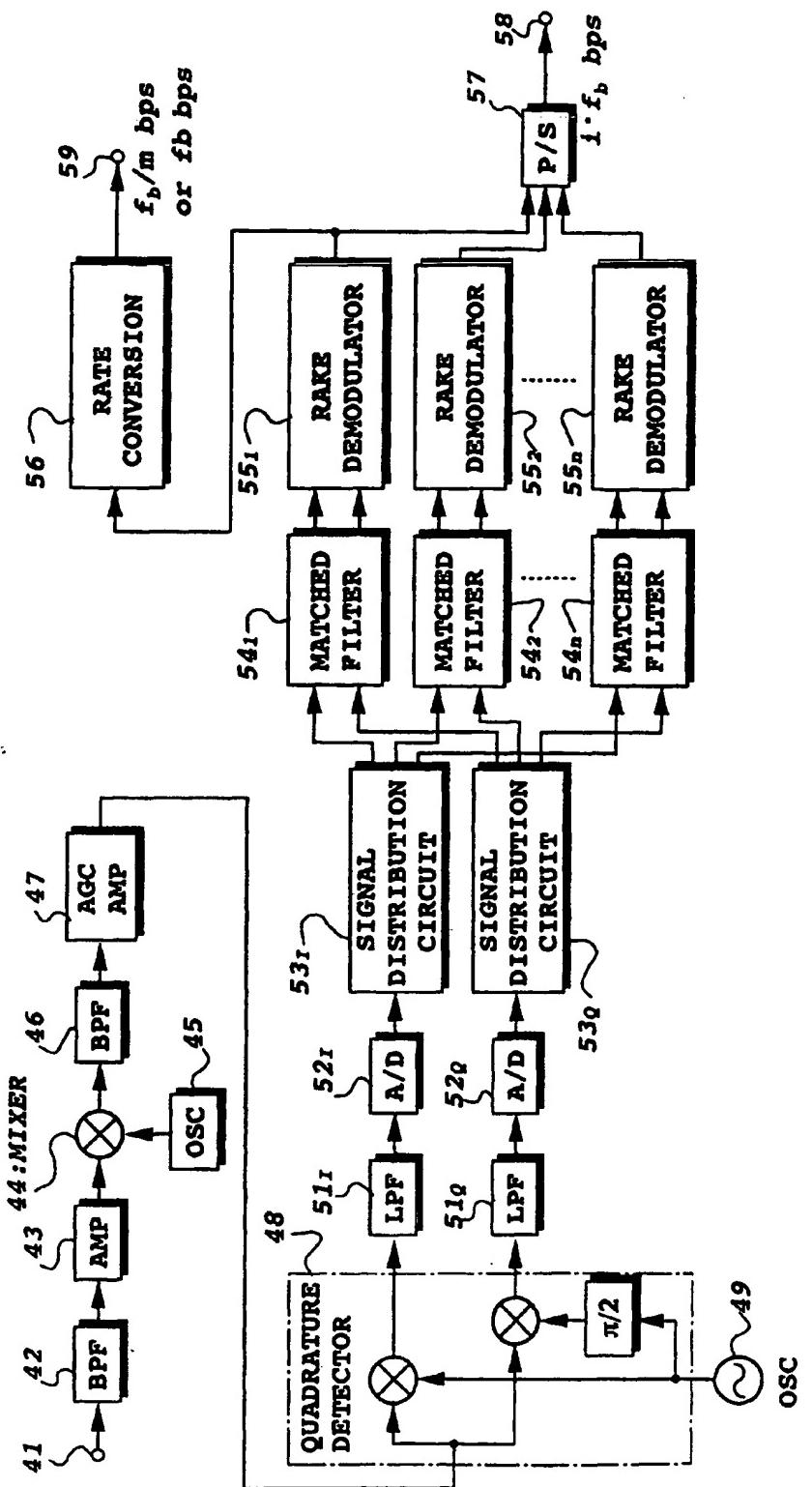
FIG.4
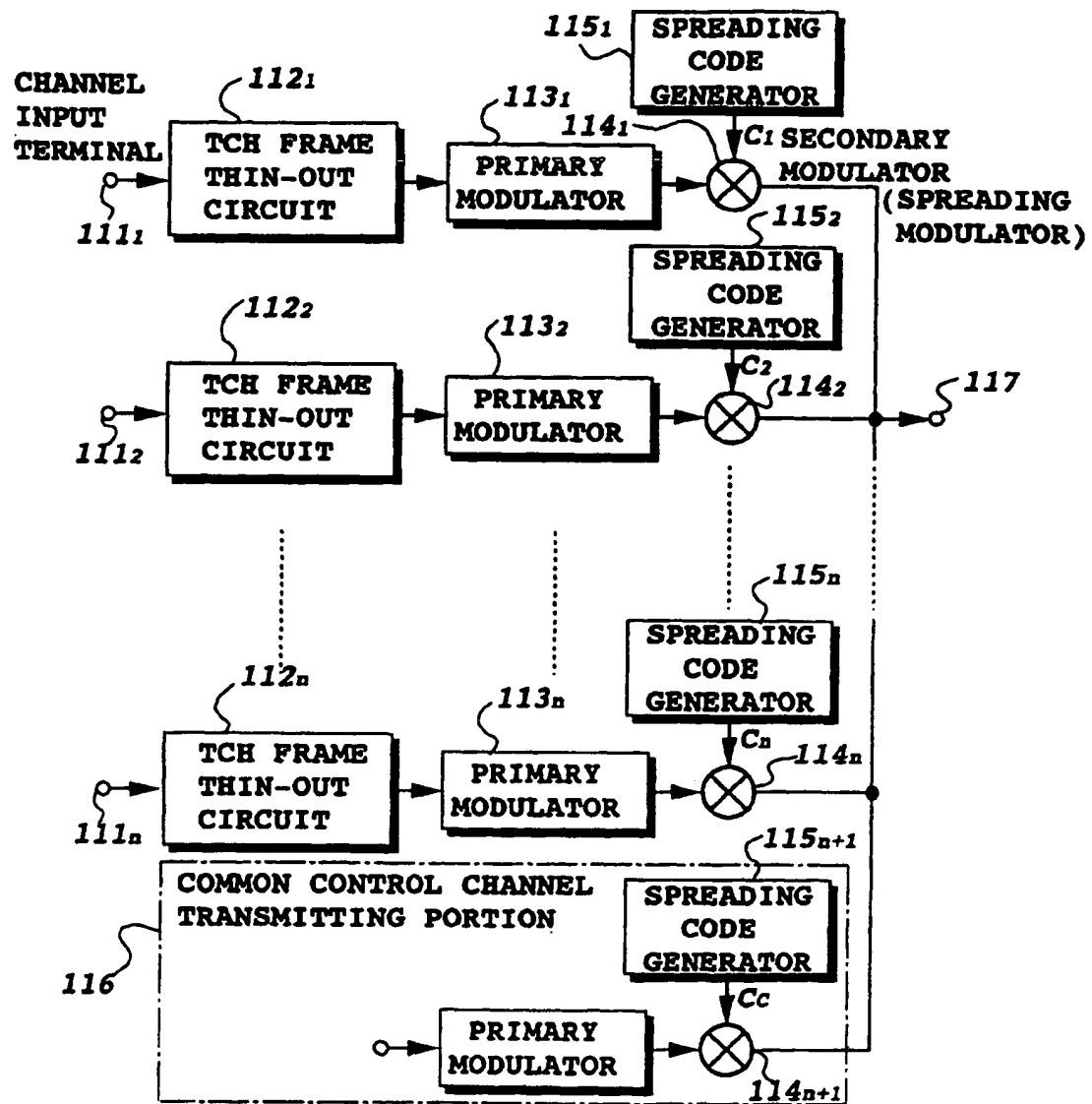
FIG.5
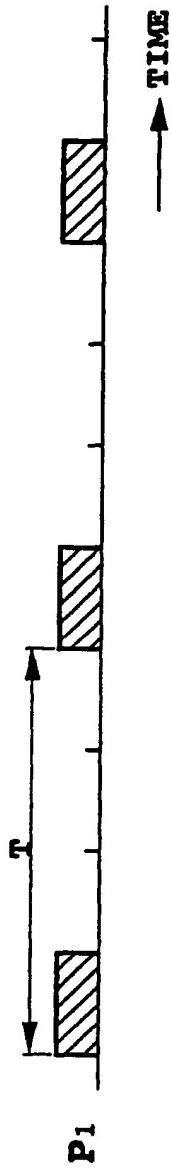
FIG.6A

FIG.6B

FIG.6C

FIG.7

FIG.8A   FRAME PULSE

FIG.8B   (a) RECEIVED
          PACKET P₂

          (b) EXPANDED
          PACKET

FIG.8C   TRANSMITTED
          PACKET

FIG.8D   RECEIVED
          SPREADING
   CODE

FIG.8E   RECEPTION OF
          COMMON CONTROL
          CHANNEL
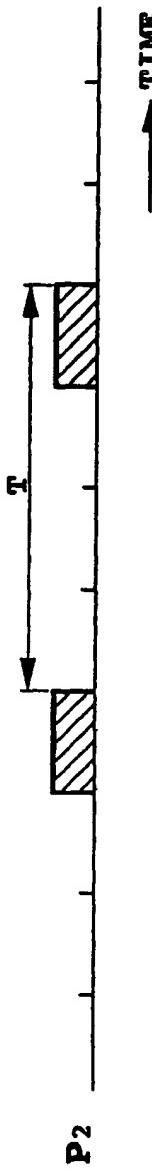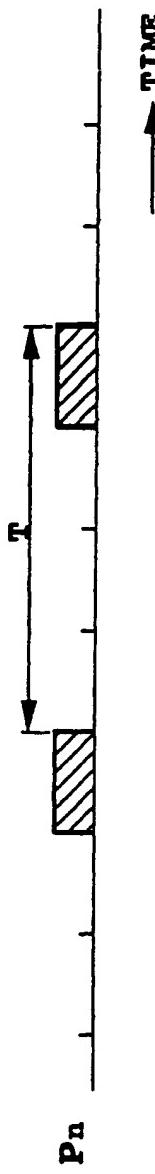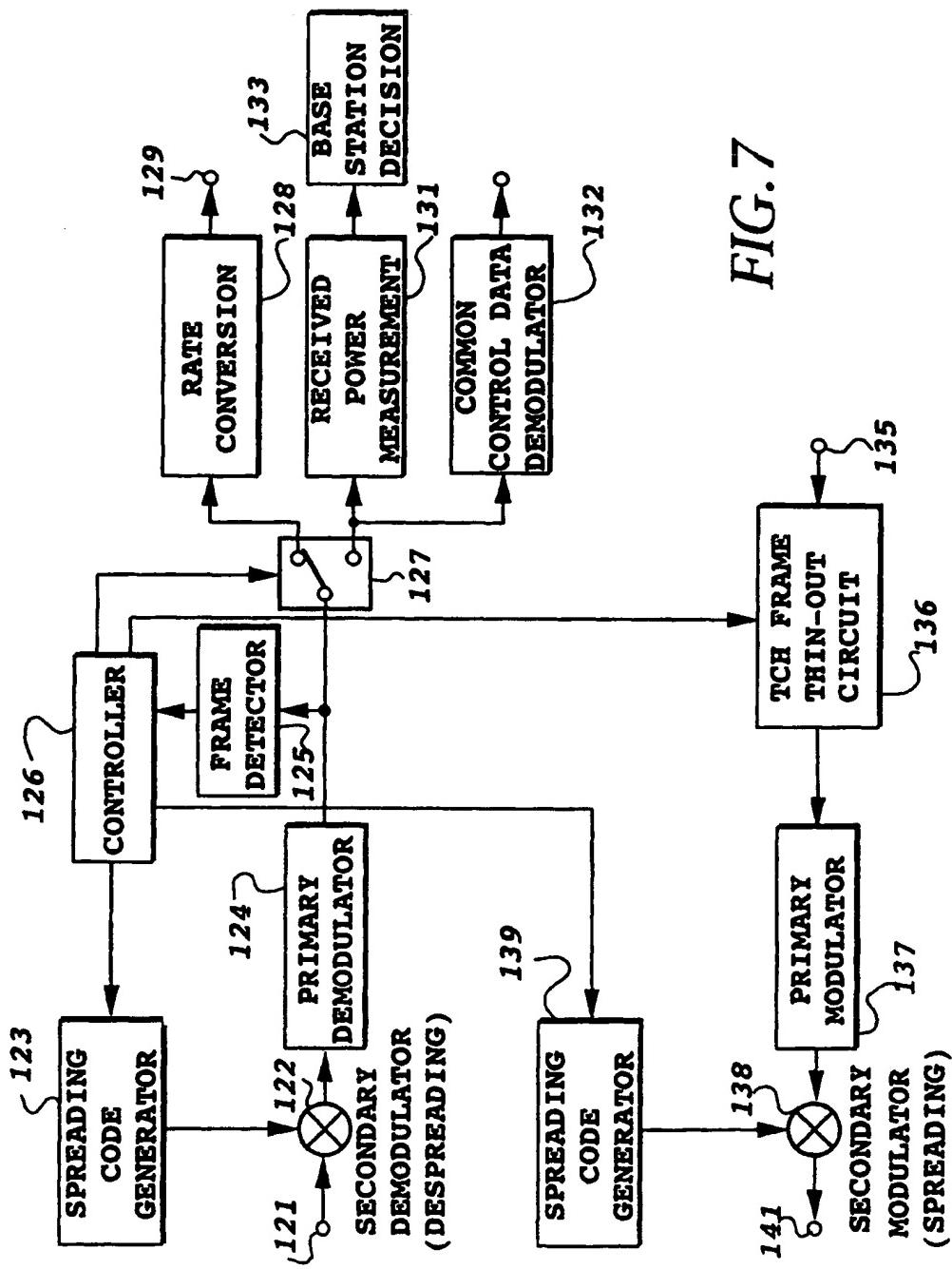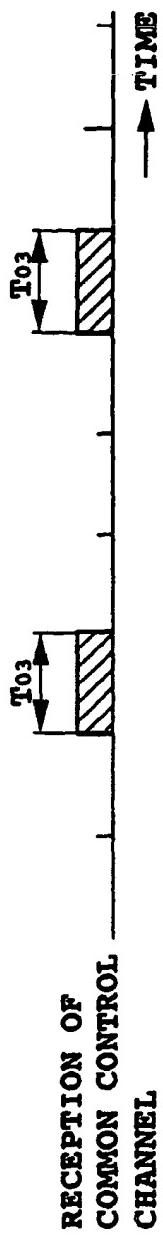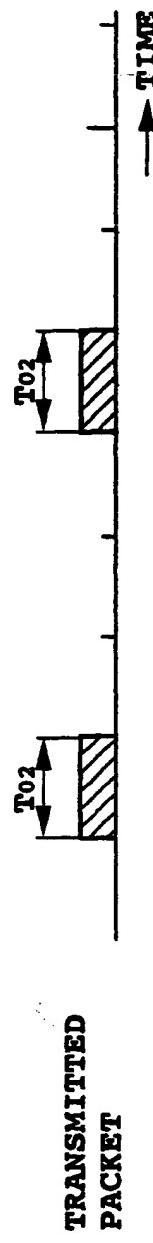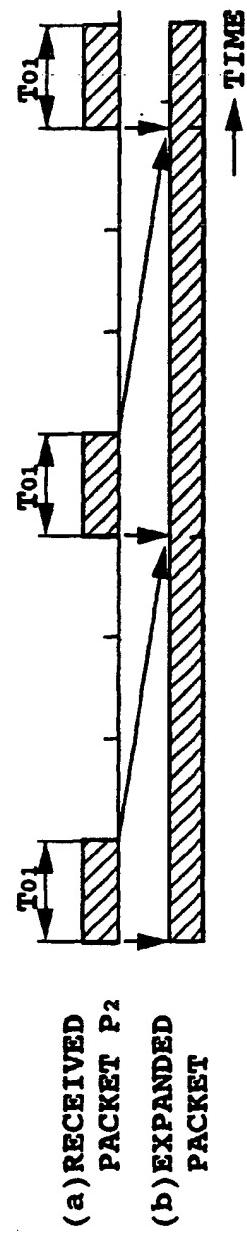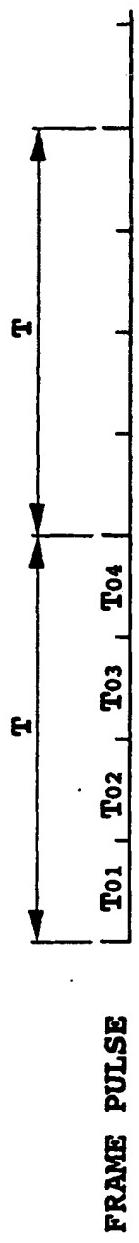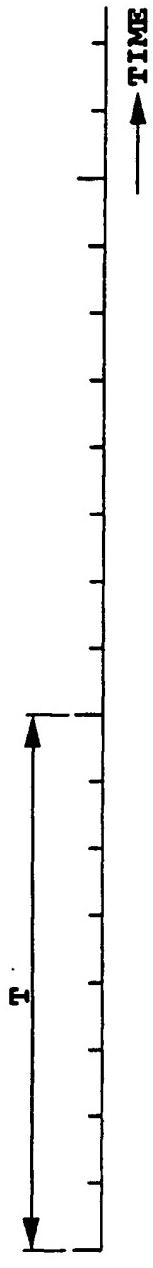
FIG.9A
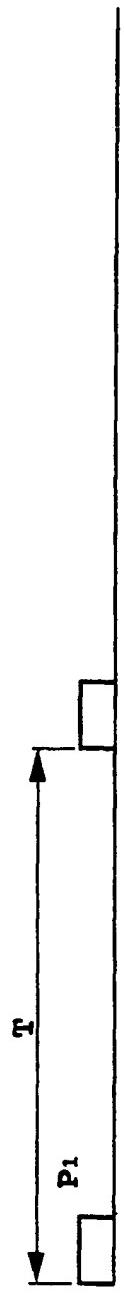
FIG.9B

FIG.9C

FIG.9D

FIG.9E

FIG.9F